

6.111 Project Abstract: A volumetric LED dot-matrix display

David Wyatt
Lawrence Wujanto

Description

Many aspects of humanity's endeavours require the effective visualisation of three-dimensional data – from studying the structures and interactions of biochemicals, designing a new space vehicle, extracting a relationship from multi-variable plots in economics, to the planning of a new piece of sculptural artwork or playing the latest computer game.

Traditional, flat-panel-based 3d displays suffer a variety of shortcomings that could be overcome by a true volumetric display – one where the display of a volume of space actually occupies a volume (composed of “voxels”, volumetric pixels). We propose to build such a display that uses a cubic lattice of LEDs – with, as a compromise between resolution and complexity, 1000 voxels – and one or more systems to generate data to be displayed on it.

Project structure

As this project will be undertaken by a pair, we propose the following work decomposition:

1. **Data generation subsystem:** this will generate successive frames of data to be displayed in the cube, which will be written to an area of RAM that will act as a “space buffer”. Ideally, a modular design will be used so multiple alternative algorithms can be written; possible applications include:
 - 3d Pong
 - 3d cellular automata
 - Display of arbitrary 3d data stored on a CompactFlash card
 - Music visualisations
2. **Display subsystem:** this will take the data from the space buffer and display it on the cube. Potential implementation issues with this subsystem have been recognised:
 - A multiplexing system must be used, trading off display update rate and/or LED duty cycle for decreased complexity and I/O pin requirement. Acceptable levels of each should be determined.
 - Allied to this is the problem of power requirement. Depending on the multiplexing strategy chosen, the power drawn by all the LEDs that are lit at one time may exceed the capabilities of the labkit's output pins. In this case, external driver circuitry and power supplies may be needed.

If these problems or others make it impossible to implement this subsystem successfully, it would be possible to simulate its functionality (and thus show the output of the data generation subsystem) by providing the capability to generate an image of the cube on a monitor via the VGA output port.

Required resources

- 6.111 Labkit
- Xilinx ISE software for development
- 1000 discrete LEDs
- Hardware to mount/support LEDs in a lattice
- (potentially) LED driver circuitry and external power supply
- (potentially) CompactFlash card

Prior work

LED cubes:

- James Clar (<http://www.jamesclar.com/product/2005/3dcubewhite/index.html>)
- Network Wizards: Cubatron (<http://nw.com/nw/projects/cubatron/>)
- Todd Holoubeck (<http://www.toddhouloubek.com/projects/ledpage/>)
- Chris Lomont (<http://www.lomont.org/Projects/LEDCube/LEDCube.php>)

Other volumetric 3d displays:

- Actuality Systems (<http://www.actuality-systems.com/>)
- Felix 3D (<http://www.felix3d.com/>)